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THE FEEDING VALUE OF CANE MOLASSES [1]

L. L. Clamohoy, L. L. Calo and O. A. Palad

III. AS A DRY-PASTURE SUPPLEMENT FOR NATIVE AND GRADE CATTLE [2]

MATERIALS AND METHODS

Eighteen dry cows and heifers (8 native and 10 grade) were separated into two comparable groups.

The pasture for these animals was divided and the groups assigned at random for continuous grazing. The pasture grasses consisted of mixed native grasses and infested with Mimosa, Lantana and Calopogonium.

Both groups of animals were fed rice straw *ad libitum* in feed racks in the pastures. In addition, lot 1 received cane molasses over the straw in amounts equal in weight to the straw. Any refused feed was accounted for.

The animals in both groups had free access to water, salt and shade.

Body weights were taken on three consecutive days at the beginning and end of the experiment, and at 28-day intervals during the experiment. In addition, all animals were scored according to their physical condition, general thriftiness and condition of hair coat at the beginning and end of the trial by three experienced animal husbandmen.

RESULTS AND DISCUSSION

Body weight and physical condition. The animals fed with cane molasses gained a total of 37.2 kg., or 0.44 kg. daily during the 84-day period, compared with 26.7 kg., or 0.32 kg. daily for the control group not fed with molasses. While there is a difference in favor of molasses, the difference is insignificant.

There was a noticeable difference in the hair coats and general physical condition of the animals favoring the group not fed with molasses. The difference was obtained after the initial grades of the

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[1] Central Experiment Station Contribution No. 873.

[2] Former Visiting Cornell Professor K. L. Turk participated in this experiment.

animals were compared with the final grades. Those which were fed with cane molasses improved during the progress of the experiment; the animals in the control group, on the other hand, did not score as well at the end of the trial as they did at the beginning.

Feed consumption. The animals in lot 1 consumed an average of 2.0 kg. each of rice straw and of molasses daily; those in lot 2 consumed only 1.1 kg. of rice straw daily. This relatively low consumption of rice straw in lot 2 may be explained by its low quality. Several experiments elsewhere have shown that cane molasses sprinkled over low-quality roughage increases the consumption of the roughage.

IV. AS RATION FOR LACTATING DAIRY CARABAOS AND COWS [3]

MATERIALS AND METHODS

In set I eight lactating carabaos and in set II, 10 lactating cows similar in milk production, age and weight were used and fed in a reversed type of experiment.

The animals in each set were divided into two groups of comparable milk production, age and weight.

The amount of grain fed to each cow was determined during the preliminary feeding period in accordance with the rates of milk production. This amount was used to feed the animals during the first week of the experimental periods, after which grain feeding was reduced arbitrarily at the rate of 0.1 kg. a day per cow for each succeeding week in accordance with the normal decline in milk yield. The amount of grain fed to each cow in two feedings daily and that refused by the animals were recorded.

Corn and grass silages were fed daily at the rate of 3 kg. to 100 kg. of liveweight of the animals. The amounts fed and refused were weighed each day and samples were taken periodically for chemical analysis.

The animals were allowed to graze in the same pasture, and were given free access to salt and water.

A sample of each of the ingredients and of the final concentrate mixtures were taken for chemical analysis.

Daily milk yields of each cow were recorded and samples were taken from one day's yield each week for butterfat test.

---

[3] Messrs. M. V. Terciño and D. Z. Canet participated in this experiment.

Body weights were based on the weights of the animals during the three successive days at the start and end of each experiment.

The concentrate mixtures for the animals were as follows:

INGREDIENT	RATION 1 (Control)	RATION 2 (Experimental)
Ground Yellow Corn	31	11
Cane Molasses	—	20
Copra Meal	31	31
Rice Bran, Fine	31	29
Fish Meal	5	7
Mineral Mixture	1	1
Table Salt	1	1
Total	100	100

RESULTS AND DISCUSSION

Milk and butterfat production. The average total milk production of the corn-fed group in set 1 was 265.93 kg. during the nine-week period; and the molasses-fed group, 288.88 kg., for the same period, with a difference of 37.08 kg. in favor of the former.

The average total butterfat production of the corn-fed group was 22.6 kg. and that of the molasses-fed group, 20.59 kg., or a difference of 1.57 kg. in favor of the corn-fed group.

The milk and butterfat production of the corn-fed group was slightly higher than that of the molasses-fed group. The average butterfat test of the corn-fed group was 8.33 per cent, and that of the molasses-fed group, 8.99 per cent. The molasses-fed group had a slightly higher butterfat test than the corn-fed group.

However, when the milk production was converted to 4 per cent F.C.M. (fat corrected milk) and the weighted daily average was analyzed statistically, the difference was insignificant.

In set II, Group I animals had an average milk production of 422.4 kg. for the entire period and Group II, 421.9 kg. There was a decrease in production of the animals in each group at the end of the experiment due to other factors, one of which was the stage of lactation. Consequently, when fat and milk production were converted to 4 per cent F. C. M. in both replications, the difference between the two concentrate mixtures containing ground corn and cane molasses was insignficant.

Feed consumption. In set I, the corn-fed group consumed an average total of 264.65 kg. of concentrates in a period of nine weeks, or a daily average of 4.27 kg.; the molasses-fed group had an aver-

age total of 246.35 kg. and a daily average of 3.94 kg. in the same period. A difference of 18.30 kg. of the average total of concentrates and the average daily difference of 0.33 kg. was noted in favor of the corn-fed group. When the average daily concentrate consumption was analyzed statistically, no significant difference was observed.

In set II, the animals in Group II had an average daily consumption of 2.2 kg. of the cane molasses mixture and those in Group I, 2.1 kg. of the ground corn mixture (without cane molasses).

The silage consumption of the corn-fed group in set I averaged a total of 1587.20 kg. for the nine-week period and the molasses-fed group, 1994.70 kg. for the same period, or a total difference of 407.50 kg. in favor of the molasses group. The weighted daily average silage consumption of the corn-fed group was 25.19 kg.; the molasses-fed group, 31.66 kg. This difference when analyzed statistically, was found to be insignificant.

In set II, the silage consumption of the molasses-fed group averaged 36.17 kg. daily, and that of the corn-fed group, 32.88 kg. In both replications the differences of the total concentrate consumption between the two rations were insignificant. The silage consumption of the molasses-fed group was significantly greater at 5 per cent level. There was an increase in silage consumption during the latter part of the study when feed available from the pasture was low.

Body weight. The total gain in weight of the corn-fed group in set I was 55.0 kg., or a daily average gain in weight of 0.87 kg.; the molasses-fed group had a total gain of 32.5 kg., or a daily average gain in weight of 0.52 kg.

In set II, Group I animals had an average gain in weight of 9.6 kg. for the entire period; Group II animals, 15.2 kg. for the same period.

In both replications the difference in gain in weight was not statistically significant. In set I, Group I animals had a tendency to lose weight when the feed had molasses, but they recovered when corn was added to the ration. In set II, there was a tendency among the animals in both groups to lose weight when the ration had no molasses, but they recovered when the ration with cane molasses was given them.

The molasses-fed group required greater amounts of concentrates and silage than the corn-fed group in set 1. The daily aver-

age gain in weight for the corn-fed group was also twice as much, disregarding the greater food intake of the molasses-fed group.

In set II, there were no significant differences observed between groups as to the amount of feed required to produce a kilogram of milk or butterfat and for a kilogram gain in weight.

V. AS RATION FOR FATTENING STEERS

MATERIALS AND METHODS

Ten grade steers were divided into two groups of similar blood composition, weight and age.

The feed mixtures for animals of each group follow:

GROUP I
(Experimental)

INGREDIENT	AMOUNT (kg.)	D.P.	T.D.N.
Cane Molasses	1.00	0.0090	0.5660
Copra Meal	.55	.1029	.4444
Rice Bran	.20	.0176	.1354
Fish Meal	.21	.0998	.1420
Mineral Mixture	.02		
Table Salt	.02		
Total	2.00	0.2293	1.2878
Para Grass	19.00	.19	2.0
Grand Total	21.00	.4193	3.2878

GROUP II
(Control)

INGREDIENT	AMOUNT (kg.)	D.P.	T.D.N.
Ground Yellow Corn	0.67	0.04958	0.56347
Copra Meal	.55	.1029	.4444
Rice Bran, Fine	.20	.0176	.1354
Fish Meal	.21	.0998	.1420
Mineral Mixture	.02		
Table Salt	.02		
Total	1.67	0.26988	1.28527
Para Grass	19.00	.19	2.0
Grand Total	20.67	.45988	3.28527

The animals were housed side by side in a shed provided with feeding troughs and soilage racks. Exercise paddocks of equal size were made on the eastern end of the shed for the animals to roam around.

Concentrates were given every morning and soilage in the afternoon. Refused soilage was taken and weighed every feeding time. Animals were provided with sufficient water and salt daily.

The weight of the animals taken on three successive days at the start served as the initial weight and that noted on the last three days of the experiment was considered the final weight.

RESULTS AND DISCUSSION

Body weight. The average total gain in weight for Group I was 47.4 kg. and for Group II, 48.2 kg. There was no significant difference in total gain in weight between the two groups, indicating that molasses mixture has just the right nutrients for fattening as corn mixture.

Feed consumption. The concentrate consumption for Group I was slightly more than that of Group II, largely due to molasses being bulky and requiring more to equalize its D.P. and T.D.N. with that of the corn, thus showing a slightly larger amount of concentrate consumption per animal.

The roughage consumption for both groups was practically equal.

SUMMARY AND CONCLUSIONS

1. For nursing Murrah calves, rations containing ground yellow corn and cane molasses did not produce significant differences in body weights and measurements.

2. For growing dairy animals, rations containing ground yellow corn and cane molasses did not produce significant differences in body weights and measurements.

3. For maintaining native and grade beef cows during summer when rice straw was the only roughage available, animals consumed more rice straws when cane molasses was poured over it, and consequently, they had bigger gains in weight and were in better physical condition.

4. For lactating dairy cows and Murrah carabaos, ration containing cane molasses had comparable results as ration containing ground yellow corn in effecting gain in weight and in the production of milk and butterfat.

5. For fattening steers, ration with cane molasses produced animals as fat as those fed ration with ground yellow corn.

6. Cane molasses replacing partially or fully ground yellow corn in concentrate mixtures or when added as a supplement to rice straw for summer feeding, produced comparable results with ground yellow corn on equal or identical D.P. or T.D.N. basis.

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A STUDY OF THE INDISTINCT BASAL SPACING OF CLAY MINERALS [1]

N. L. GALVEZ

WITH FIVE TEXT FIGURES

Digestion of soil clay minerals for four hours in 0.5N NaOH on a hot plate caused a solution of alumina-silicate of the ratio 1:1.5 for Guadalupe clay and 1:1.4 for Guimbalaon clay. (These ratios are within the range given by Ross and Kerr for amorphous material, allophane.)

Guadalupe clay showed the presence of iron-allophane which, after the removal, permitted the individual montmorillonite crystals to show its distinct x-ray diffraction pattern in the region of 18A°. Guimbalaon clay, after the removal of allophane, exhibited much more respectable peak at 7.2A°. These improvements of the x-ray diffraction patterns were attributed to the collapse and removal of the tightly cementing materials consisting of SiO_2, Al_2O_3, and Fe_2O_3.

Fe_2O_3 is a strong contributor but not the sole factor in the poor x-ray patterns of Guadalupe clay.

Montmorillonite layers of Guadalupe clay were able to disperse themselves independently and reconstitute into respectable lattice when freed from electrostatic coprecipitation.

Fe_2O_3 in iron-allophane in Guadalupe clay can not be removed by treating the specimen merely with dithionite-citrate reagent without digestion with 0.5N NaOH solution.

Indistinct x-ray diffraction patterns of these specimens were caused not by a single factor but by various factors. The most important of these are the diluent and masking effects of iron-allophane-like materials and the existence of interstratification of minerals of relatively poorer crystalline structure compared to the minerals present in the temperate soils.

In an earlier paper (Galvez, 1957), it was reported that Guadalupe clay exhibited indistinct basal spacing in the region of 18A° and Guimbalaon clay, in the region of 7.2A°. These indistinct x-ray diffraction patterns were interpreted as (1) indicating complex interstratification, (2) suggesting lack of optimum crystalline structure of the minerals, and (3) allowing for the presence of some intimately mixed amorphous materials.

[1] Central Experiment Station Contribution No. 874. This paper is a part of the article on "Mineral content of four soils representing major soil types of the Philippines," which was given grant-in-aid by the John Simon Guggenheim Memorial Foundation and performed during the writer's sabbatical leave from the University of the Philippines from January, 1956 to July, 1956, in the Soils Laboratory at the University of Wisconsin with occasional consultation with Prof. M. L. Jackson.

MATERIALS AND METHODS

The above hypotheses were tested by subjecting 200 mg. clay mineral specimen to the digestive action of 100 ml., 0.5 N NaOH solution in a nickel beaker kept for four hours gently boiling (Dyal, 1953) in the determination of free alumina and free silica.

The suspension was transferred into a centrifuge tube and then centrifuged for 5 minutes at 2200 rpm. The clear liquid was carefully decanted.

The extracts were made up to 250 ml. and analyzed for Si, Al, and Mg. Aluminum was determined after the removal of Si by the use of 8 ml. 60 per cent $HClO_4$. The dissolved materials were determined colorimetrically except Mg which was determined with the use of a Beckman photoelectric spectrometer Model DU (Corey and Jackson, 1953).

The residue was washed with 200 ml. dilute HCl solution (pH-3.5). The washings were combined and made up to 250 ml. volume and then also analyzed for Si, Al, Fe, and Mg in a manner similar to the decantate.

The washed residue was freed from iron oxides by the dithionite-citrate method (Aguilera and Jackson, 1953) and washed four times with 80 to 90 per cent methanol before subjecting it to x-ray analysis, cation exchange capacity, surface determination, and electron micrography, each of which was carried out in accordance with Jackson (1949).

The extracted iron was determined spectrophotometrically with the use of KSCN solution.

RESULTS AND DISCUSSION

The major constituents of the extract are given in table 1.

TABLE 1.—*Major constituents of the amorphous materials* [a]

CONSTITUENTS	GUADALUPE CLAY 0-6″ <0.08μ Per cent		GUIMBALAON CLAY 0-15″ 0.08-0.2μ Per cent	
	Decantate	Washings	Decantate	Washings
SiO_2	16.80	3.03	23.80	2.36
Al_2O_3	17.40	4.20	27.40	3.75
Fe_2O_3 [b]	6.27	0.60	0.71	0.13
MgO	—	0.21	—	0.07
Al_2O_3/SiO_2	1/1.5		1/1.4	

[a] Based on the constituents of the clay mineral specimen.
[b] Fe_2O_3 dissolved by dithionite-citrate reagent from the residue.

Based on the respective constituents, Guadalupe clay digested with 0.5 N NaOH solution lost 42 per cent SiO_2, 92 per cent Al_2O_3, 46 per cent Fe_2O_3 and 10 per cent MgO. The ratio of the dissolved Al_2O_3 and SiO_2 is 1:1.5 and is very close to the ratio of Al_2O_3 and SiO_2 in allophane. Ross and Kerr (1934) reported that amorphous material, allophane, has a ratio of Al_2O_3:SiO_2 ranging from 1:1 to 1:2.

Guimbalaon medium clay likewise lost 61 per cent SiO_2, 81 per cent Al_2O_3, 37 per cent Fe_2O_3 and 50 per cent MgO. The molecular ratio of the extracted alumina and silica is 1:1.4 which is also within the ratio limit given to amorphous material commonly found in clays (Ross and Kerr, 1934).

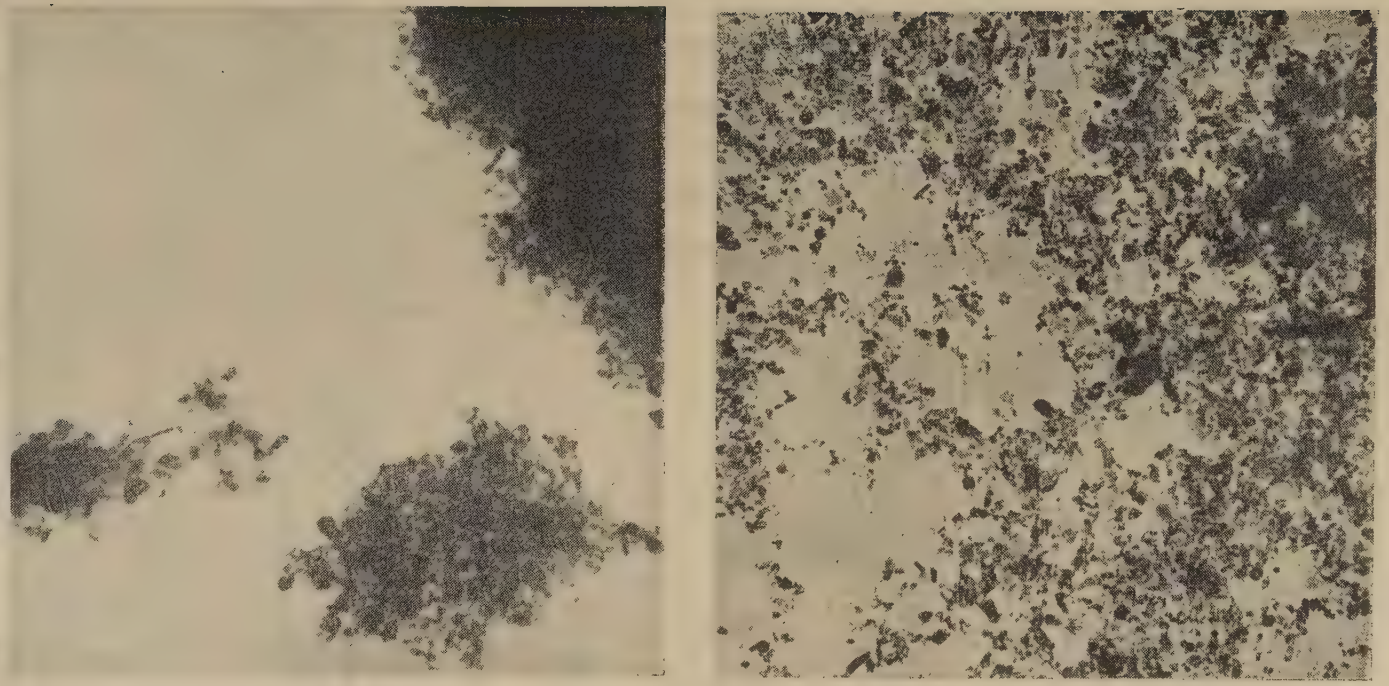
The digested clays suffered significant changes in the specific surface. Guadalupe fine clay "maximum per cent" of montmorillonite was reduced from 180 to 46. Calculated as "maximum per cent" of vermiculite, these correspond to 360 and 92, respectively. The low final surface may be attributed to the still remaining diluent of low surface allophane consisting of large particles (Whittig and Jackson, 1954).[2] On the other hand, the cation exchange capacity was increased from 42 m.e. (milli-equivalent) of Ca per 100 grams to 72.3 m.e. which is almost twice as much as the untreated (table 2).

TABLE 2.—*Effects of 0.5N NaOH treatment on the surface measurement and cation exchange capacity*

PROPERTIES	GUADALUPE CLAY <0.08μ		GUIMBALAON CLAY 0.08-0.2μ	
	Untreated	Treated	Untreated	Treated
m^2/g	1,213	299	488	912
Max. of mont.	180	46	66	123
Max. of verm.	360	92	132	246
CEC m./100 sample	42	72.3	11.7	53.2

Guimbalaon clay, on the other hand, increased its maximum per cent of montmorillonite and the computed vermiculite. The percentage increases were from 66 to 123 and 132 to 246, respectively. This may be attributed to the opening up of some layers and holes of the halloysite crystals. This is confirmed by the increased cation exchange capacity. The untreated has only 20 per cent as much exchange capacity as the treated specimen.

[2] Being prepared for publication.



Before treatment

After treatment

Fig. 1.—Electron micrography of Guimbalaon medium clay (0.08μ–0.2μ) before and after treatment with 0.5 N NaOH solution. Magnification 5900×.

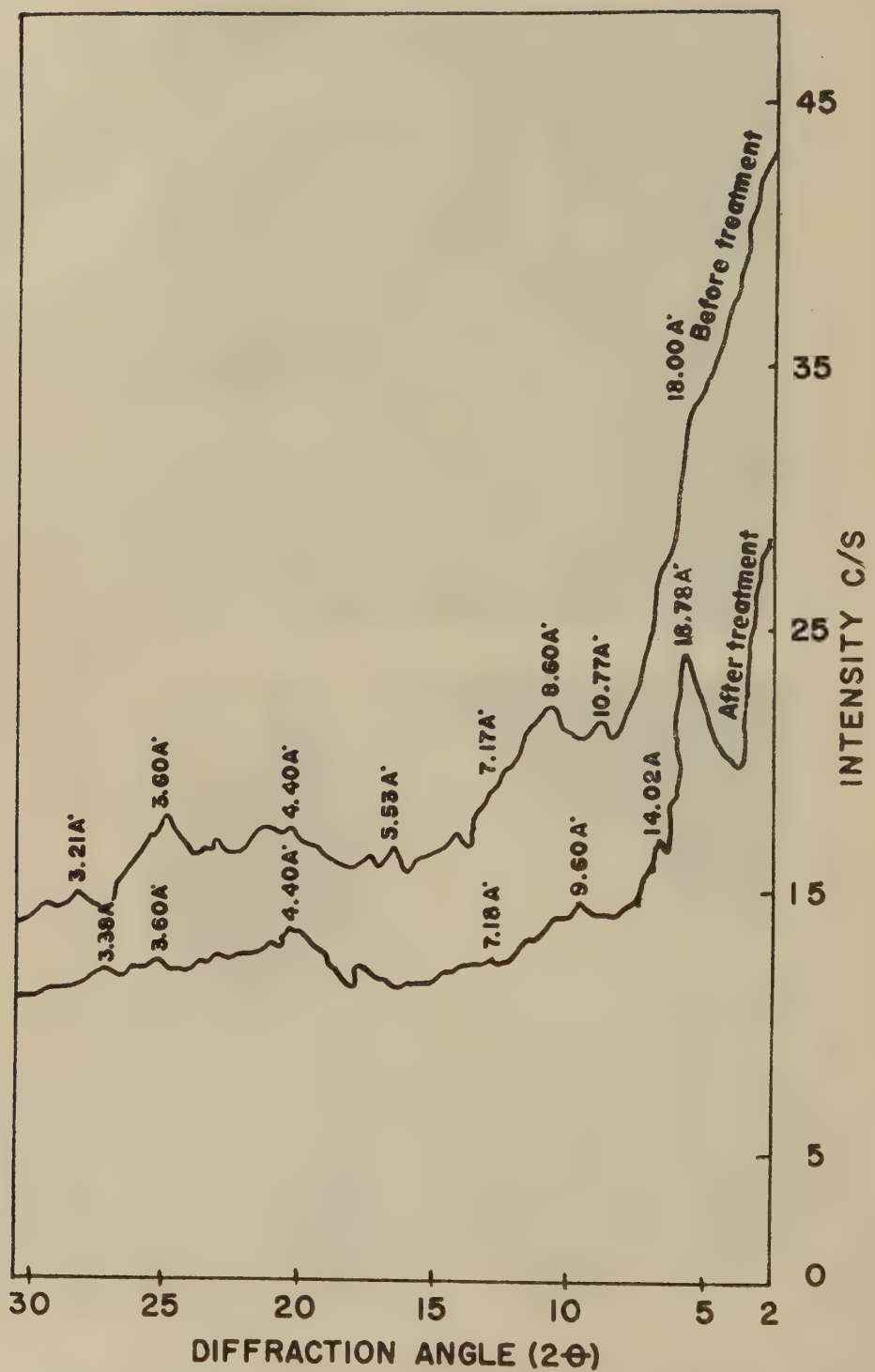


Fig. 2.—Guadalupe clay (<0.08μ), before and after treatment.

The electron micrography of the clays shows that the clay particles are larger and more flocculated in the untreated than in the treated specimen (fig. 1). Also, the residues exhibit more scattering of uniform size particles than the untreated specimens.

The x-ray diffraction patterns show that the broad basal spacing at 18A° of the untreated Guadalupe clay became a highly appreciable peak after the digestion with 0.5 N NaOH and removal of the dissolved materials consisting chiefly of iron allophane (fig. 2 and table 1).

In figure 3, the improvement of the x-ray diffraction pattern of Guimbalaon clay is also attributed to the separation of iron-allophane-like materials (table 1).

The foregoing results highly suggest that the indistinct peak of Guadalupe clay at 18A° and Guimbalaon clay at 7.2A° is due partly to the diluted effect and partly to the masking effect of the iron-allophane-like materials which have been removed in good amounts from the specimens (table 1).

To check this kind of reasoning Guadalupe clay previously digested with 0.5N NaOH was studied by precipitating the dissolved materials inside and outside the clay system. The first is termed "chemically mixed" and the second "physically mixed", having the same dilution as the former.

The montmorillonite peak of the "chemically mixed" specimen wherein the dissolved materials were not removed (fig. 4A) is not as distinct as that wherein Fe_2O_3 was removed (fig. 4B). When the removed Fe_2O_3 was returned and then intimately mixed with the clay, the x-ray diffraction pattern became indistinct (fig. 4C). The intimate mixing with the clay of Fe_2O_3 from $FeCl_3$ and NaOH produced a pattern (fig. 4D) which is as poor as any x-ray pattern of specimen containing Fe_2O_3. These findings highly suggest that suspension of Fe_2O_3 from the clay itself or from $FeCl_3$ chemically mixed are equally effective in blocking the montmorillonite basal x-ray diffraction and that Al_2O_3, SiO_2, and MgO were not the main cause of poor x-ray diffraction.

The clay "physically mixed" with the dissolved materials shows results parallel to their corresponding treatments in the chemically mixed.

A question that could be asked from these results is, why not remove iron oxide (without digesting the sample) with 0.5N NaOH if iron oxide is the only material obstructing the montmorillonite

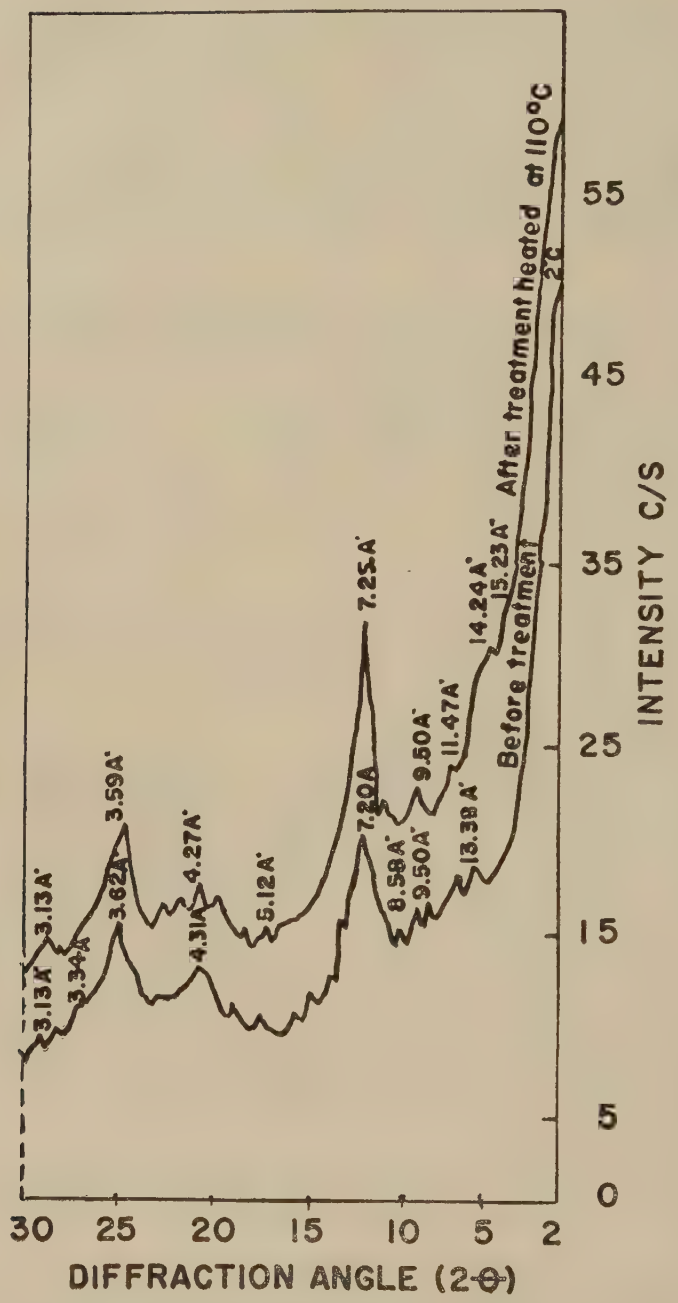


Fig. 3.—Guimbalaon clay ($<0.08\mu$), before and after treatment.

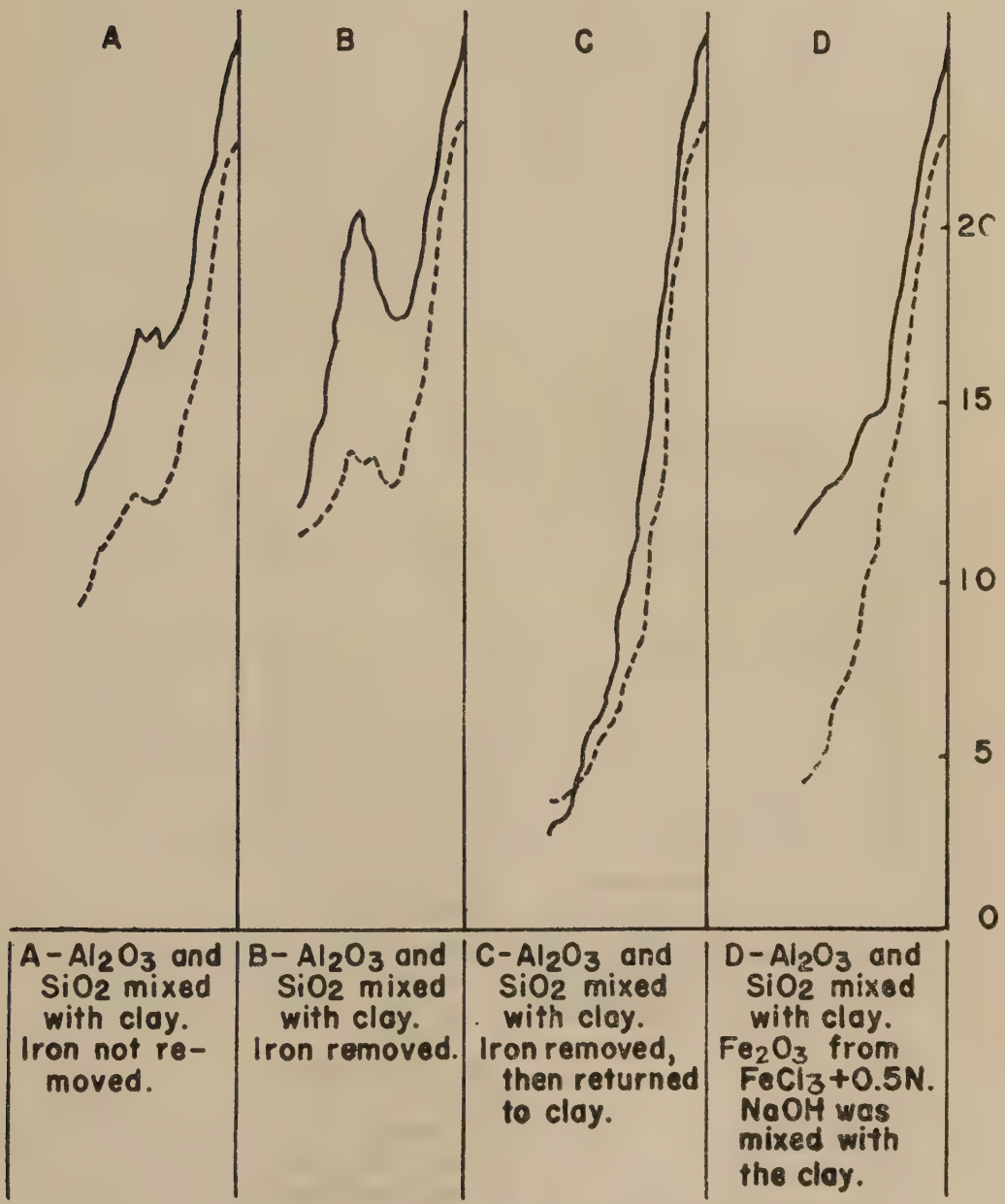

A
B
C
D
20
15
10
5
0
A-Al2O3 and SiO2 mixed with clay. Iron not removed.
B-Al2O3 and SiO2 mixed with clay. Iron removed.
C-Al2O3 and SiO2 mixed with clay. Iron removed, then returned to clay.
D-Al2O3 and SiO2 mixed with clay. Fe2O3 from FeCl3+0.5N. NaOH was mixed with the clay.

Fig. 4—X-ray diffraction pattern of "chemically mixed" and "physically mixed" Guadalupe clay in the region of 18 Angstrom units. Solid line—chemically mixed, precipitation within the clay. Dotted line—physically mixed, precipitation outside the clay.

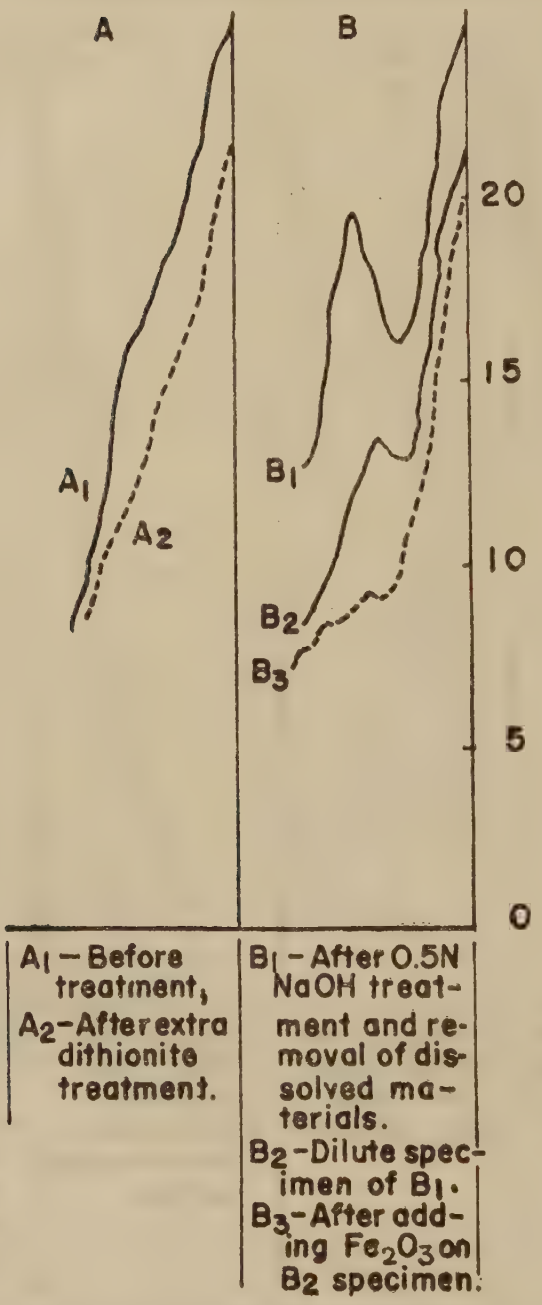


Fig. 5.—X-ray diffraction pattern at 18 Angstrom units before and after extra dithionite treatment.

x-ray diffraction? The x-ray pattern of such a specimen, fig. $5A_2$ broken line, wherein the sample was further treated with dithionite-citrate reagent without previous digestion with 0.5N NaOH solution indicates that dithionate-citrate alone could not remove the iron oxide in this particular sample. It is concluded that loosening of the iron-allophane materials by 0.5N NaOH digestion is essential before the iron oxides, which caused indistinct basal spacing, could be removed.

Applying suspension of Fe_2O_3 on specimen B_2 caused the loss of the montmorillonite peak, suggesting that Fe_2O_3 coating around the montmorillonite particles is significantly effective in blocking the montmorillonite basal x-ray diffraction, fig. $5B_3$ broken line. Dilution lowered the peak. B_1 shows a much higher peak than B_2, a diluted specimen of B_1.

From these findings, it might be advanced that the montmorillonite crystals have been "synthesized" by the 0.5 NaOH solution. Such suggestion could not be entertained in view of the fact that the specimen showed a very strong line (hko) 4.50A in the photographic recording indicating that the individual montmorillonite layers were crystalline in the first place.

It is also inferred that the complete precipitation of electrostatic (−) Fe_2O_3 and (−) montmorillonite resulting in the random arrangement of the montmorillonite layers instead of parallel stacking is the main cause of broad scattering. In this connection, van Schuylenborgh (1950) gave the isoelectric point (pH 8.5) for amorphous ferric hydroxide and 8.3 for amorphous Al-hydroxide. He claimed that hydragyllite, $Al(OH)_3$ with an isoelectric point of 4.8 is sufficiently positive to form precipitates with electro-negative silica.

These results suggest that the montmorillonite layers of these clays can disperse themselves independently and reconstitute into respectable layered lattice when freed from electrostatic coprecipitation.

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STARCH, TOTAL SUGAR AND MOISTURE CONTENTS OF *BAMBUSA VULGARIS* SCHRAD. IN RELATION TO INFESTATION BY *DINODERUS MINUTUS* FABR.[1]

G. B. Viado and M. M. Ylagan

No marked difference in starch and total sugar contents existed between the one- and two-year culms of *Bambusa vulgaris* Schrad. However, the top portion of the culms contained slightly more starch than the basal portion but the top portion contained slightly less total sugar than the basal portion. Both culms attained their maximum starch content in March, which is considered the driest month of the year. The younger culm contained more moisture than the older culm but both contained more moisture at the base than at the top. There was no correlation between moisture content and rainfall. The one-year culm was more susceptible to *Dinoderus minutus* Fabr. than the two-year culm. No apparent correlation existed between susceptibility to infestation and starch, total sugar, or moisture content. The more infestation at the lower portion of the culm may be due to more wood or tissue which could support more beetles than the upper portion of the culm.

In an earlier work (Viado, 1955), the lower portion of the culm of *Bambusa vulgaris* Schrad. was observed to be more susceptible to the attacks of *Dinoderus minutus* Fabr. than the upper portion. Plank (1946) found that there was more beetle attack in the bottom internodes than in those at the top.

Same investigators ascribe the difference in susceptibility to borer attack of different portions of the bamboo culm to different factors. High initial moisture content was found by Plank (1945) to be accompanied by high susceptibility and the parts containing the most moisture also contained the most starch. Differences in borer infestation were found by Plank and Delgado (1948) to be closely correlated with the starch content of the bamboo as indicated by the iodine spot test. However, Plank and Hageman (1951) stated that the intensity of reaction to the iodine spot test was a reliable indication of starch concentration and the intensity of subsequent infestation, only within certain limits.

The present investigation was conducted in the Departments of Entomology and Chemistry and at the Faculty Hill, U.P. College

[1] Central Experiment Station Contribution No. 875.

of Agriculture, from August 1953 to December 1956, to determine the starch, total sugar and moisture contents of one- and two-year culms of *Bambusa vulgaris* at different months of the year and their relation to infestation by *Dinoderus minutus*.

MATERIALS AND METHODS

The bamboo culms which were taken from the same source as those used in an earlier work (Viado, 1955) were marked to keep track of their ages. One 1-year and one 2-year culms were cut every month for two years. The culms were sawed into one-meter lengths soon after harvesting, and each split into ten parts, cleaned, sorted and bundled. The splits were divided into ten bundles, each representing all the sections in both culms. The bundles were exposed to beetle infestation as in the previous test, but without treatment. The number of entrance and emergence holes were counted weekly for 14 weeks.

Two sawdust samples for starch, total sugar and moisture analysis were obtained, one from the basal two meters and another from the top four meters of each culm. Each sample was mixed thoroughly prior to analysis. The method of analysis for starch determination followed was the direct acid hydrolysis, which is taken, together with the method for analysis of total sugar, from the official methods of analysis of the Association of Official Agricultural Chemists (Horwitz, 1955). The moisture contents of the samples were based on the fresh samples and determined soon after the samples were taken to prevent the loss of moisture. The percentages of starch and total sugar were based on dry weight.

DISCUSSION OF RESULTS

The average number of entrance and emergence holes in a one-meter section of the culms was used as basis for comparing the susceptibility of the two kinds of culms to borer attack (table 1). These averages varied considerably between the culms and between months of the year. The one-year culm apparently was more susceptible than the two-year culm, which partly corroborates the result obtained in an earlier test. The average number of entrance holes per section of the one-year culms for the 24-month period was 322.6 while the corresponding figure for the two-year culms was only 281.3. In the younger culm the highest average number of entrance holes (780.1) was recorded in January 1955 and the lowest (128.4) in June 1956, while in the older culm the highest (942.6) was also recorded in January, 1955 but the lowest (105.2), in January, 1956.

The ratio of the entrance holes to the emergence holes in both culms was taken to determine which months of harvest were favorable to the increase of beetle population (table 1). The one-year culm had a higher average ratio (2.07) than the two-year culm (1.69). The monthly fluctuations of the ratios appear to follow more or less the same pattern for both culms. It is apparent that alternating periods of high and low ratios was observed in four-month duration, the first period from August to November 1954 being high and the next period from December 1954 to March 1955 being low. This sequence was repeated in the next eight months, but not for the rest of the 24-month period, indicating that other factors interfered with this regularity. The periods of low ratios appear to coincide with the periods of high parasitism of the beetle as shown by the prevalence of adult parasites during those months.

The starch content of both the one- and two-year culms varied each month for the duration of the test (tables 2 and 3).

TABLE 1.—*Average number of entrance and emergence holes to a meter section of the one- and two-year culms*

NO.	HARVESTED	ONE-YEAR CULM			TWO-YEAR CULM		
		Entrance	Emergence	Em/En	Entrance	Emergence	En/Em
1	22-VIII-1954	288.4	1,149.0	3.99	107.1	402.9	3.76
2	19- IX - "	590.8	2,245.0	3.80	338.0	1,619.5	4.79
3	22- X - "	269.4	1,247.7	4.63	119.6	173.4	1.45
4	23- XI - "	509.9	1,438.3	2.82	725.2	1,347.3	1.86
5	21- XII- "	157.0	118.1	0.75	413.3	652.6	1.58
6	24- I -1955	780.1	417.3	0.53	942.6	473.4	0.50
7	23- II - "	577.5	1,307.8	2.26	125.4	169.0	1.35
8	24- III- "	435.9	772.5	1.77	362.7	286.8	1.09
9	21- IV- "	316.9	792.7	2.50	274.1	379.1	1.38
10	24- V - "	167.0	578.6	3.46	120.3	275.8	2.29
11	24- VI- "	285.9	1,033.5	3.61	190.4	531.1	2.79
12	21- VII- "	160.0	201.6	1.26	318.4	685.4	2.15
13	24-VIII- "	599.4	1,183.4	1.97	303.9	279.0	0.92
14	22- IX - "	336.3	555.1	1.65	246.4	229.8	0.93
15	20- X - "	166.5	38.3	0.23	385.0	294.0	0.76
16	23- XI- "	384.9	442.7	1.15	405.8	173.1	0.43
17	22- XII- "	181.9	424.2	2.33	160.0	392.9	2.46
18	21- I-1956	146.2	166.5	1.14	105.2	146.9	1.40
19	20- II- "	297.2	200.9	0.68	256.5	266.9	1.04
20	23- III- "	191.2	478.3	2.50	153.1	242.8	1.58
21	20- IV- "	279.1	769.0	2.75	154.8	219.6	1.42
22	22- V- "	264.5	281.2	1.06	191.6	224.3	1.17
23	20- VI- "	128.4	204.2	1.59	207.2	458.5	2.21
24	20- VII- "	229.2	265.0	1.20	144.8	183.2	1.26
Total		7,743.6	16,310.9	49.63	6,751.4	10,107.3	40.57
Average		322.65	679.62	2.07	281.31	421.14	1.69

TABLE 2.—*Percentages of starch, total sugar, and moisture contents of one- and two-year culms of Bambusa vulgaris harvested monthly for twenty-four months*

MONTH	ONE-YEAR CULM						TWO-YEAR CULM					
	Base			Top			Base			Top		
	Starch	Total sugar	Moisture	Starch	Total sugar	Moisture	Starch	Total sugar	Moisture	Starch	Total sugar	Moisture
August, 1954	28.34	2.54	46.55	28.07	2.61	31.38	25.83	2.68	36.90	24.85	3.04	42.69
September	28.44	4.65	32.92	33.59	2.73	27.86	24.13	3.41	43.64	28.68	3.58	40.18
October	24.02	4.56	36.64	24.24	3.37	29.92	27.84	3.96	38.71	31.34	2.03	26.91
November	30.19	2.89	31.74	28.18	2.12	25.87	26.33	3.30	49.75	27.14	3.32	37.98
December	31.89	5.83	67.95	30.78	3.30	49.65	26.51	3.74	44.32	30.59	2.64	28.06
January, 1955	27.06	3.46	30.33	24.24	3.40	34.08	30.23	5.36	29.10	29.39	2.61	21.34
February	31.60	3.45	47.28	33.16	4.78	47.53	33.50	3.61	34.96	32.99	2.04	32.50
March	35.51	3.13	30.10	37.14	3.37	34.71	36.11	2.81	47.60	36.84	2.59	30.52
April	29.02	3.21	35.43	27.61	3.21	30.46	24.94	5.13	35.68	28.85	3.43	25.41
May	28.36	3.10	27.09	22.94	4.45	31.65	23.69	3.56	41.92	23.38	5.56	37.80
June	22.07	4.07	35.60	30.64	3.92	34.00	27.43	4.61	34.47	27.92	3.53	30.80
July	24.84	2.60	39.36	19.79	2.48	38.50	28.05	3.14	22.35	24.76	4.03	27.58
August	28.69	2.51	46.29	29.51	3.32	48.42	25.86	1.85	31.97	24.05	2.34	38.04
September	26.94	4.50	41.87	32.57	3.55	48.19	25.71	3.19	36.67	27.24	2.83	27.54
October	23.08	4.13	49.39	23.87	3.11	39.84	27.54	2.45	29.88	31.98	3.02	32.06
November	29.90	2.66	36.18	29.72	3.32	27.67	25.99	4.06	38.36	27.24	2.87	31.82
December	26.97	3.73	53.88	33.26	4.66	45.28	30.72	3.10	34.85	30.66	2.99	29.33
January, 1956	26.60	2.64	43.88	25.14	2.39	28.39	29.69	6.78	45.76	32.20	3.70	36.35
February	27.56	2.93	45.47	32.31	4.40	44.76	33.44	3.04	37.62	32.68	2.61	26.80
March	36.86	3.49	39.68	38.25	3.22	28.96	35.70	3.50	30.91	37.59	4.80	40.09
April	29.67	3.73	55.88	27.76	3.43	61.29	24.60	4.58	41.21	28.93	4.89	42.22
May	28.97	3.21	53.15	28.53	3.63	40.81	28.46	4.22	41.71	28.26	3.26	30.72
June	23.66	3.01	41.22	30.11	3.08	42.61	20.93	3.07	31.36	20.78	4.47	31.76
July	30.37	3.41	40.72	23.15	4.92	52.21	37.39	3.85	36.87	30.70	4.01	35.44
Total	680.61	83.44	1,008.60	694.56	82.77	924.04	680.62	89.00	896.57	699.04	80.19	783.94
Average	28.36	3.48	42.02	28.94	3.45	38.50	28.36	3.71	37.36	29.13	3.34	32.66

The averages for the 24-month period, however, did not show marked variation. It is interesting to note that the average starch content of the basal portion of the culm was the same (28.36 per cent) for both the one- and two-year culms. The starch content of the top, however, varied slightly in both culms and was slightly higher than that of the base. In Puerto Rico, Plank and Delgado (1948) reported that in this species of bamboo the base of most of the culms, regardless of age, contained more starch than either the middle or top portion.

TABLE 3.—*Mean percentages of starch, total sugar, and moisture contents of one- and two-year culms of Bambusa vulgaris harvested monthly for twenty-four months*

MONTH	ONE-YEAR CULM			TWO-YEAR CULM		
	Starch	Total sugar	Moisture	Starch	Total sugar	Moisture
August, 1954	28.21	2.58	38.97	25.34	2.86	39.80
September	31.02	3.69	30.39	26.41	3.49	41.91
October	24.13	3.97	33.28	29.59	2.99	32.81
November	29.18	2.51	28.81	26.74	3.31	43.86
December	31.34	4.57	58.80	28.55	3.19	36.19
January, 1955	25.65	3.43	32.21	29.81	3.98	25.22
February	32.38	4.12	47.41	33.25	2.83	33.73
March	36.33	3.25	32.41	36.48	2.70	39.06
April	28.32	3.21	32.95	26.90	4.28	30.55
May	25.65	3.78	29.37	23.53	4.56	39.86
June	26.35	3.99	34.80	27.68	4.07	32.63
July	22.32	2.54	38.93	26.41	3.58	24.96
August	29.10	2.91	47.35	24.95	2.09	35.01
September	29.75	4.02	45.03	26.47	3.01	32.11
October	23.48	3.62	44.62	29.76	2.73	30.97
November	29.81	2.99	31.93	26.62	3.46	35.09
December	30.11	4.19	49.58	30.69	3.05	32.09
January, 1956	25.87	2.52	36.13	30.94	5.24	41.06
February	29.93	3.67	45.12	33.06	2.82	32.21
March	37.55	3.35	34.32	36.64	4.15	35.50
April	28.72	3.58	58.58	26.76	4.73	41.72
May	28.75	3.42	46.98	28.36	3.74	36.22
June	26.89	3.05	41.92	20.85	3.77	31.56
July	26.76	4.16	46.46	34.04	3.93	36.15
Total	687.83	83.12	968.35	689.83	84.56	840.27
Average	28.66	3.46	40.35	28.74	3.52	35.01

When the average starch contents of both culms for the 24-month harvesting period were superimposed upon each other both culms attained their maximum starch content in March, which coincides, more or less, with the driest part of the year (table 4). This month, however, did not coincide with the peak of *Dinoderus* infestation. When infestation was compared with starch contents of the culms month for month, it was apparent that no agreement existed between starch content of the culm and severity of infestation by *Dinoderus minutus*. This result does not conform with the findings of Gardener (1945) in India and Plank and Delgado (1948) in Puerto Rico. Plank and Delgado (1948) reported that beetle infestation was closely correlated with the starch content of the culm as indicated by iodine test. These investigators further stated that while the hydrolysable carbohydrate content was a good indicator of susceptibility to infestation, the starch content was a more accurate basis. Gardner (1945), however, found that such correlation existed only until May after which borer attack was lower than would be expected. This same author reported that in Dehra Dun, the starch content of living culms is highest in May and June, gradually decreases in July and August, rapidly after September, reaches the minimum in November and December and then rises up to May.

The average total sugar content of the base and top of both culms also did not vary markedly, although that of the top was slightly lower than that of the base in both culms. In the one-year culm the average total sugar content of the base was 3.48 per cent, compared with 3.45 of the top. The corresponding figures for the two-year culm were 3.71 and 3.34 per cent, respectively. Comparison of the graphs on total sugar and infestation showed no apparent correlation. Plank and Hageman (1951) reported that reducing sugars do not constitute an important factor which influences infestation.

The one-year culm contained more moisture than the older culm. In both culms, the moisture content of the base was higher than that of the top. The average moisture content of the base was 42.02 per cent for the younger culm and 37.36 for the older. The corresponding figures for the top were 38.50 and 32.66 per cent, respectively. Plank (1945) found that in Puerto Rico, there was a tendency for high initial moisture content to be accompanied by high susceptibility and that the parts of the culm which contained the most moisture contained the most starch.

TABLE 4.—*Average monthly temperature, rainfall and relative humidity for the duration of the experiment*

MONTH	TEMPERATURE	RAINFALL	RELATIVE HUMIDITY
	°F	*inches*	*per cent*
August, 1954	79.3	9.18	81.6
September	80.9	7.21	80.3
October	81.3	6.38	81.1
November	78.9	5.70	82.2
December	76.6	7.25	87.2
January, 1955	76.4	5.09	87.4
February	78.0	0.14	69.1
March	79.7	0.38	61.6
April	82.6	1.90	64.8
May	84.4	5.90	64.8
June	82.1	4.57	76.2
July	81.5	4.99	75.4
August	81.3	5.43	77.8
September	81.3	6.08	77.8
October	81.2	8.47	76.9
November	78.7	15.64	79.7
December	76.2	0.93	74.3
January, 1956	76.9	1.61	76.3
February	79.1	0.07	68.7
March	79.9	0.96	66.6
April	82.1	3.93	69.2
May	82.2	8.26	75.1
June	82.1	7.11	76.3
July	81.5	9.94	79.3
Total	1,924.2	127.12	1,809.7
Average	80.18	5.30	75.40

There was no apparent relation between intensity of infestation by borers and either moisture, starch, or total sugar content. No relationship existed between moisture content and rainfall (tables 2, 3 and 4) during the months and years covered by the experiment. The greater infestation on the basal portion of the culm may be attributed to the thicker wood or tissue which could support more beetles than the top portion.

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RESISTANCE OF LOWLAND RICE VARIETIES TO RICE BLAST [1]

RODOLFO C. GALLARDO

Of the 21 lowland rice varieties tested for resistance to rice blast, Inomay, Malaman, and Ac 440 Dr. 260 showed the least infection under greenhouse conditions. These varieties may serve as source of resistance to blast when used as parent stocks in rice hybridization. Varieties Intan, Baiang, Apostol, Paimat, Milfor 6 (2), Tjereh Mas, Mas Java, Ac 224 C-24, and Masa merit further study since they also showed some degree of resistance.

Rice blast, caused by *Piricularia oryzae* Cav., is one of the most destructive diseases which attacks rice in the Philippines and other rice-producing countries. It affects both the leaves and panicles of the host plant. If rice plants are attacked sufficiently early, there is no filling-out of grains and the panicles remain erect; if infection starts a little later when grains have already filled, the panicles drop over at the neck region with the weight of the grain, and are thus prevented from maturing completely. In either case, the disease usually causes much reduction in yield.

Many control measures for rice blast have been recommended by various workers; however, the most effective and economical control would be the production of disease-resistant varieties. For this reason, it is important to secure definite and reliable information on the relative resistance of rice varieties.

Studies have shown that different varieties of rice show different degrees of resistance or susceptibility to the disease. Akai (1939) reported that rice seedlings transplanted from moist soils are more resistant than those transplanted from dry soil. This is because there are more silicated epidermal cells per unit area, especially the bulliform cells which are easily penetrated by the causal fungus, in plants transplanted from dry beds than in those from moist beds.

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According to Sawada (1937), nitrogen is closely associated with the invasion of blast disease. Parallel to the increase of nitrogen in manure, the injurious effect of the disease gradually rises, because as the leaf area increases, the thickness decreases and the walls of the epidermal cells become thinner than normal.

Suzuki (1935) stated that regardless of the growth stage or variety of rice, or the amount of fertilizer or silica given, the susceptibility to blast is lower in flooded soils without added silica than in dry soils with silica.

The present study was conducted from December, 1954, to October, 1956, in the laboratory of the Department of Plant Pathology and in the lowland rice field of the Central Experiment Station, in order to (1) test the resistance of different local and introduced lowland rice varieties to rice blast under laboratory conditions, and (2) observe the reaction to the disease of these varieties under field conditions.

MATERIALS AND METHODS

Disease-free seeds of 21 local and introduced early-maturing lowland rice varieties, furnished by the Division of Plant Breeding, Department of Agronomy, were used. Each variety was grown in earthen pots of the same size whose holes were plugged so that water would not drain easily. The pots were filled up to almost level of the mouth with sterilized soil suitable for lowland field cultures. Three trials each consisting of three replications were carried out. More than 15 seeds were sown in each pot but later thinned to 10 plants to a pot when the seeds had germinated.

The causal fungus was isolated to pure culture from naturally infected rice leaves. Among the media tested for maximum spore production, rice decoction agar proved to be the best medium, although polished rice agar was also relatively efficient.

The plants were inoculated at 3 different stages of development; at seedling, tillering, and boot stage. They were sprayed evenly with a DeVilbiss hand atomizer with the same amount of inoculum consisting of a suspension of spores and mycelial fragments to which 0.25 per cent of gelatin was added as recommended by Anderson and Henry (1946). The plants were later on sprayed with sterile distilled water from time to time for at least 12 hours, as recommended by Hemi and Abe cited by Andersen, Henry, and Tullis (1947), to pre-

vent the spores from drying up before they were able to cause infection. The check plants were sprayed only with sterile distilled water. The check and inoculum-treated plants were kept in the greenhouse for four days after spraying. They were then transferred to a shady place outside for further observation.

The criteria used in evaluating resistance or susceptibility were the following: incubation period of the disease, percentage of infected plants, average number of spots per leaf, average number of spots per plant, size of lesions, and the rapidity with which the spots developed. The system of rating the varieties with regard to the degree of resistance or susceptibility is patterned after the method designed by Elliott and Jenkins (1946) for Helminthosporium leaf blight of corn. The ratings fall into six categories, as follows:

0.5—very slight infection
1.0—slight infection
2.0—light infection
3.0—moderate infection
4.0—heavy infection
5.0—very heavy infection

Field observations on the plantings conducted by the Division of Plant Breeding were made to determine whether or not the reaction of the different varieties to the disease under greenhouse conditions would be similar to that under field conditions.

RESULTS AND DISCUSSION

Experiment I. Inoculation was done when the seedlings were four weeks old. The plants had three to four leaves and were more or less one foot high. Positive reaction in all the varieties was observed (table 1). Disease ratings ranged from very slight to heavy infection. Varieties Baiang, Apostol, Malaman, Inomay, and Ac 440 Dr. 260 showed the least infection, while varieties Brondol Putih, Ac 435 T/W 42, Dudk-Kuning, and Salak proved to be the most susceptible to the disease. Generally, the older leaves were readily infected.

Experiment II. The potted plants were inoculated at tillering when they were eight weeks old and more or less one and one-half foot high. As in the first trial, all the varieties were infected by the fungus. Higher degrees of infection were observed on some of the

TABLE 1.—*Results of inoculating different varieties of rice with Piricularia oryzae Cav. at seedling stage (4 weeks)*

VARIETY	MEAN NO. OF LESION PER PLANT	DISEASE RATING
Malaman	2.9	0.5
Inomay	3.4	0.5
Ac 440 Dr. 260	3.6	0.5
Intan	4.8	1.0
Apostol	4.0	0.5
Paimat	4.8	1.0
Milfor 6 (2)	5.5	1.0
Masa	5.3	1.0
Baiang	3.8	0.5
Tjereh Mas	5.9	1.0
Ac 224 C-24	5.6	1.0
Mas Java	6.2	2.0
Peta	8.4	3.0
Gendjah Bonton (b)	7.9	3.0
Nagadhan	8.3	3.0
Milagrosa	8.9	3.0
Shrivimankote	9.1	3.0
Dudk-Kuning	10.7	4.0
Salak	10.0	4.0
Brondol Putih	10.4	4.0
Ac 435 T/W 42	10.2	4.0

varieties, compared to those in experiment I. Baiang and Apostol were resistant in the seedling stage but appeared susceptible at the tillering stage, while the reverse was true for Peta (table 2).

Experiment III. To test further the resistance or susceptibility of the plants another trial was made at a later stage of development. The plants were inoculated at boot stage, when they were 12 weeks old and two feet high. Their somewhat yellowish color might have been due to lack of nutrients in the soil.

In general, the varieties appeared less susceptible as evidenced by the lower mean number of spots per plant compared to the seedling and tillering stages. However, some varieties appeared as susceptible to the disease as in the tillering stage. The enlargement of the spots was very slow as was also observed during the two previous trials. Table 3 shows the results of the experiment.

TABLE 2.—*Results of inoculating different varieties of rice with Piricularia oryzae Cav. at tillering stage (8 weeks)*

VARIETY	MEAN NO. OF LESION PER PLANT	DISEASE RATING
Malaman	9.3	0.5
Inomay	9.4	0.5
Ac 440 Dr. 260	10.0	0.5
Intan	11.3	0.5
Apostol	13.3	1.0
Paimat	12.1	1.0
Milfor 6 (2)	10.0	0.5
Masa	12.6	1.0
Baiang	14.4	2.0
Tjereh Mas	12.8	1.0
Ac 224 C-24	11.7	1.0
Mas Java	8.7	0.5
Peta	13.1	1.0
Gendjah Bonton (b)	10.9	0.5
Nagadhan	15.2	2.0
Milagrosa	18.4	3.0
Shrivimankote	17.9	3.0
Dudk-Kuning	18.9	3.0
Salak	21.9	4.0
Brondol Putih	20.0	4.0
Ac 435 T/W 42	22.9	5.0

Table 4 provides a summary of the disease ratings of all the varieties for the three stages, together with the mean disease rating and the mean incubation period for the three stages. In all trials, the lesions ranged from one to three millimeters in width, and from three to 15 millimeters in length. The spots were yellowish brown, irregularly shaped, and somewhat elongated. The susceptible varieties had bigger leaf spots than the resistant ones.

The incubation period of the disease varied from 4.7 to 8.6 days. In general, the incubation period for the varieties found resistant was longer than that of the varieties more or less susceptible. For Malaman, Inomay, and Ac 440 Dr. 260, all with disease ratings of 0.5, the incubation periods were 8.6, 7.8, and 7.7 days, respectively. On the other hand, for Ac 435 T/W 42 with a disease rating of 5.0, and Brondol Putih, Dudk-Kuning, and Salak with disease ratings of 4.0, the incubation periods were 4.9, 4.7, and 5.1 days, respectively.

The mean disease ratings in the three experiments are shown in table 4. Malaman, Inomay, and Ac 440 Dr. 260 showed resistance,

TABLE 3.—*Results of inoculating different varieties of rice with Piricularia oryzae Cav. at boot stage (12 weeks)*

VARIETY	MEAN NO. OF LESION PER PLANT	DISEASE RATING
Malaman	3.5	0.5
Inomay	5.6	0.5
Ac 440 Dr. 260	6.7	0.5
Intan	4.0	0.5
Apostol	6.3	0.5
Paimat	4.6	0.5
Milfor 6 (2)	6.9	1.0
Masa	4.3	0.5
Baiang	4.9	0.5
Tjereh Mas	7.2	1.0
Ac 224 C-24	9.9	1.0
Mas Java	7.0	1.0
Peta	7.2	1.0
Gendjah Bonton (b)	7.4	1.0
Nagadhan	13.3	2.0
Milagrosa	14.1	3.0
Shrivimankote	14.7	3.0
Dudk-Kuning	18.7	4.0
Salak	19.1	4.0
Brondol Putih	18.5	4.0
Ac 435 T/W 42	20.1	5.0

while Brondol Putih, Ac 435 T/W 42, Dudk-Kuning, and Salak showed susceptibility in all three stages (seedling, tillering, and boot). While Peta obtained a disease rating of 3.0 (moderate infection) in the seedling stage, it appeared less susceptible in the tillering and boot stages, obtaining disease ratings of 1.0 (slight infection). The same was true for Gendjah Bonton (b), except that it obtained a better disease rating of 0.5 (very slight infection) in the tillering stage. There were nine varieties that obtained mean disease ratings of 1.0 for the three stages, some of which were Intan, Baiang, Apostol, Milfor 6 (2), and Tjereh Mas.

While this work was in progress, no infection was observed in field plantings; hence, no data on the disease reaction under field conditions are presented here. As reported by Reyes (1952) the disease is seasonal, so that at the time of observation the environmental conditions were possibly unfavorable for disease development.

TABLE 4.—*Summary of three inoculation trials*

VARIETY	DISEASE RATING				MEAN NO. OF LESION PER PLANT	MEAN INCUBATION PERIOD (DAYS)
	Expt. 1	Expt. 2	Expt. 3	Mean		
Malaman	0.5	0.5	0.5	0.5	5.2	8.6
Inomay	0.5	0.5	0.5	0.5	6.1	7.8
Ac 440 Dr. 260	0.5	0.5	0.5	0.5	6.8	7.7
Intan	1.0	0.5	0.5	1.0	6.7	7.7
Apostol	0.5	1.0	0.5	1.0	7.9	6.9
Paimat	1.0	1.0	0.5	1.0	7.2	6.8
Milfor 6 (2)	1.0	0.5	1.0	1.0	7.5	7.0
Masa	1.0	1.0	0.5	1.0	7.4	7.3
Baiang	0.5	2.0	0.5	1.0	7.7	7.0
Tjereh Mas	1.0	1.0	1.0	1.0	8.6	6.3
Ac 224 C-24	1.0	1.0	1.0	1.0	9.1	6.4
Mas Java	2.0	0.5	1.0	1.0	7.3	6.8
Peta	3.0	1.0	1.0	2.0	9.6	5.7
Gendjah Bonton (b)	3.0	0.5	1.0	2.0	8.7	6.6
Nagadhan	3.0	2.0	2.0	2.0	12.3	5.6
Milagrosa	3.0	3.0	3.0	3.0	13.8	5.0
Shrivimankote	3.0	3.0	3.0	3.0	13.9	4.8
Dudk-Kuning	4.0	3.0	4.0	4.0	16.1	4.7
Salak	4.0	4.0	4.0	4.0	17.0	5.1
Brondol Putih	4.0	4.0	4.0	4.0	16.3	4.7
Ac 435 T/W 42	4.0	5.0	5.0	5.0	17.7	4.9

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One of the objectives of science is to predict and control.

—*A. N. Whitehead*

* * *

Experiment, directed by the disciplined imagination either of an individual or, better still, of a group of individuals of varied mental outlook is able to achieve results which far transcend the imagination alone of the greatest philosopher.

—*Lord Rutherford*

THE COMPARATIVE PERFORMANCE OF COLLEGE 39 AND SEEDLING NO. 93 [1]

VALERIANO C. CALMA, FRANCISCO B. AMBOJIA
and SATURNINO Q. BULLAGAY

Seedling No. 93 produced more tillers to a stool and flowered more profusely than College 39.

Seedling No. 93 gave a significantly higher yield of cane than College 39 in the plant crop, but there was no statistical difference in their yield of cane in the ratoon crop. There was no significant difference in the yield of sugar in piculs to a ton cane of the two varieties in the plant crop. However, College 39 had significantly higher yield of sugar to a ton of cane than Seedling No. 93 in the ratoon crop.

This study was conducted to compare the performance of College 39 and Seedling No. 93 in the plant and first ratoon crops with regards to the important agronomic characteristics of the two varieties, such as percentage of germination, stand of plants in the field, tillering capacity, susceptibility to pests and diseases, habit of growth, whether lodging or non-lodging, flowering habit, and maturity, and (b) the comparative yields of cane and sugar to a hectare and sugar in a ton of cane of the two varieties.

This work was conducted at the Central Experiment Station field and in the laboratories of the Departments of Agronomy and Agricultural Chemistry of the College of Agriculture, Los Baños, Laguna, from December, 1952 to February, 1955.

MATERIALS AND METHODS

Methods of culture of the plant crop

A piece of land, with an area of 1,440 sq. meters and classified as clay loam, was plowed and harrowed three times. The furrows were spaced 1.2 meters apart just before planting. The area was divided into twelve plots of 120 sq. m. each. On Dec. 20, 1952, six plots, selected at random from each of six pairs, were planted to cuttings of College 39 and six to seedling No. 93. The seed

[1] Central Experiment Station Contribution No. 877. Based on theses presented by the junior authors for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Agronomy under the direction of the senior author.

pieces which contained at least three nodes or eyes each were not soaked in water because there was sufficient moisture in the soil for germination. In each plot, 100 seed peices were planted in a row, 50 centimeters apart between hills, and 15 to 20 centimeters deep in the furrow. The extra seed pieces were planted at the end of each furrow for future replanting. Missing hills in each furrow were replanted with the reserved plants. The base of the plants were fertilized with ammonium sulfate at the rate of 18 grams in each hill or about 300 kilograms to a hectare. The plants were off-barred and hilled-up twice with the native plow and handweeded around the base.

Methods of culture of the ratoon crop

After the cane trash was spread evenly over the field and burned on February 22, 1954, the field was disced and the stubbles were cut close to the ground. The cut stubbles and non-millable stalks were piled and dried along the borders of the cane field and burned to minimize the hiding places of rats. The first off-barring was done on March 6, 1954, and the second on May 29, 1954. The first hilling-up was done on March 26, 1954 and the last on June 6, 1954.

Occasional weeding between the hills and the furrows was done whenever necessary. All missing hills were replanted on June 6, 1954.

Ammonium sulfate (20.5-0-0) was applied at 20 grams to a hill around the base of the hills of the cane plants after the first off-barring.

Variability in the agronomic characters among the plant and ratoon canes were observed from the early stages of their growth to maturity.

The stand of the plants in the field was determined by counting all missing hills after harvest.

The number of millable and non-millable stalks in a stool or hill taken at random in each plot was counted at harvest.

Habit of growth, such as uprightness and lodging, and flowering were observed.

The maturity of the plants was determined weekly by using the Bausch and Lomb hand refractometer, from the time the plants were 10 months old until they were harvested.

A representative stalk from each of 10 stools or hills taken at random was cut, weighed, crushed in a handmill and the mixture

from the composite sample was analyzed for apparent purity and sucrose.[2] From these analyses, the yield in piculs of sugar per ton of cane was determined.

RESULTS AND DISCUSSION

Germination. Table 1 shows that Seedling No. 93 had a mean germination of 89.3 per cent and College 39, 70.7 per cent; the difference between their means was significant. The seed pieces that did not germinate were dug up and some were found to be attacked by termites while most of them rotted. This may have been due to excessive moisture in the soil after heavy rains.

TABLE 1.—*Actual percentage of germination*

VARIETY	REPLICATIONS					
	1	2	3	4	5	6
College 39	78	60	68	69	79	69
S. No. 93	97	79	85	93	88	91

Percentages of germination transformed to angles

VARIETY	REPLICATIONS						TOTAL	MEAN PER CENT
	1	2	3	4	5	6		
College 39	62.03	50.77	55.55	56.17	62.72	56.17	343.41	70.7
S. No. 93	80.02	62.72	67.21	73.57	69.73	72.54	425.79	89.3
Total	142.05	113.49	122.76	129.74	132.45	124.71	769.20	
Mean	89.4	69.9	77.0	81.9	83.7	81.3		

SMD (V) at 1% = 7.06

Stand of plants in the field. As shown in table 2a the mean percentage of stand of plants in the field of the plant crop of College 39 was 71.2 and that of Seedling No. 93, 88.4 per cent. Seedling No. 93 gave a significantly higher percentage of stand than College 39. Like-

TABLE 2a.—*Comparative percentages of stand transformed to angles of plant crop*

VARIETY	REPLICATIONS						TOTAL	MEAN PER CENT
	1	2	3	4	5	6		
College 39	60.00	54.94	53.93	57.04	62.72	56.98	345.41	71.2
S. No. 93	77.08	69.73	71.56	63.73	67.21	71.56	420.86	88.4
Total	137.08	124.67	125.29	120.76	129.93	128.54	766.27	
Mean	86.6	78.4	78.9	75.6	82.1	81.2		

SMD (V) at 5% = 3.72

[2] The analyses were made by Associate Professor Leopoldo J. Villanueva of the Department of Agricultural Chemistry.

wise, the ratoon crop of Seedling no. 93 gave significantly higher percentage of stand than that of College 39 as shown in table 2b.

TABLE 2b.—*Angles corresponding to percentages of stand of plants at harvesting of ratoon crop*

VARIETY	REPLICATIONS						TOTAL	MEAN	MEAN [a]
	1	2	3	4	5	6			
College 39	64.90	56.79	60.00	61.34	64.90	64.90	372.83	62.14	78.2
S. No. 93	68.87	71.56	73.57	67.21	69.73	77.08	428.02	71.34	89.8
Total	133.77	128.35	133.57	128.55	134.63	141.98			

[a] Mean percentages. SMD (V) at 1% = 7.7

Flowering. The plants in the plant crop started to flower at the age of about eleven to twelve months or 321 days after planting. Seedling No. 93 was observed to produce flowers profusely while College 39 produced flowers sparsely. Seedling No. 93 began to flower almost nine months after ratooning, while College 39 flowered a week later. Seedling No. 93 also flowered more profusely than College 39 in the ratoon crop.

Maturity. With the Bausch and Lomb hand refractometer periodic examination of the juice of the representative stalks of the two varieties were made. It was found that the plant crop of both varieties was almost mature about 14 months after planting. In the ratoon crop, Seedling No. 93 was almost mature in eleven months while College 39 was just approaching maturity in twelve months.

Habit of growth. The plant canes were upright in growth from the time of planting to seven months old. However, when the plants were about eight months old, College 39 lodged. This may have been due to its longer, larger and heavier stalks. Later, most of the stools of both varieties lodged completely due to storms on August 13, 1953, and on October 25 to October 28, 1953.

In the ratoon crop, the majority of the stools of both varieties of canes were observed to be upright in their early stage of growth. Both varieties however, lodged just after the storms on August 15, 1954; lodging was more marked on College 39 than on Seedling No. 93.

Tillering capacity. Table 3a shows the average number of millable stalks to a stool of the two varieties in the plant crop. The mean millable stalks to a stool of Seedling No. 93 was 6.3 which was significantly more than that of College 39, with a mean of 3.0 millable stalks to a stool.

Table 3b shows the comparative number of millable stalks to a stool of the two varieties in the ratoon crop. Seedling No. 93 with a mean of 7.4 had significantly more millable stalks to a stool than College 39, which had only a mean of 4.5.

TABLE 3a.—*Comparative number of millable stalks to a stool of plant crop*

VARIETY	REPLICATIONS						TOTAL	MEAN
	1	2	3	4	5	6		
College 39	3.3	3.8	2.7	2.5	2.5	3.2	18.0	3.0
S. No. 93	6.3	6.1	6.3	7.0	6.2	5.7	37.6	6.3
Total	9.6	9.9	9.0	9.5	8.7	8.9	55.6	
Mean	4.8	5.0	4.5	4.8	4.4	4.5		

SMD (V) at 1% = 1.33

TABLE 3b.—*Comparative number of millable stalks to a stool of ratoon crop*

VARIETY	REPLICATIONS						TOTAL	MEAN
	1	2	3	4	5	6		
College 39	4.5	4.6	4.6	4.3	4.4	4.4	26.8	4.5
S. No. 93	7.9	8.0	7.5	7.0	6.7	7.0	44.1	7.4
Total	12.4	12.6	12.1	11.3	11.1	11.4	70.9	

SMD (V) at 1% = 2.3

Presence of pests and diseases. No serious pests or diseases attacked the two varieties of sugar cane in the plant crop. In the early stage of growth both varieties of sugar cane were infected with *Bacillus sacchari* Roldan but this did not affect the plants seriously.

In the ratoon crop, the stalks of College 39 were more badly attacked by rats than those of Seedling No. 93. This may be attributed to the softness of its rind as compared to that of Seedling No. 93. Smut of sugar cane, caused by *Ustilago scitaminea* (Rabh.) Syd. attacked many stalks of Seedling No. 93 but none of the stalks of College 39 were infected by this disease. Some of the stalks of College 39 were attacked by Pokkah boeng, or top of sugar cane caused by *Gibberalla fujikuroi* (Saw.) Wr. = Fusarium fujikuroi (Saw.) Wr.[3]

Yield of sugar per ton of cane. Table 4a shows that the computed mean yield of sugar to a ton of cane in the plant crop was 1.20 piculs for Seedling No. 93 and 1.37 piculs for College 39. The difference is not significant.

[3] Identified by Dr. F. T. Orillo of the Department of Plant Pathology.

Table 4b shows the yield of sugar per ton of cane in the ratoon crop. College 39 gave a yield of 1.93 piculs to a ton of cane while Seedling No. 93 gave 1.68 piculs. The analysis of variance shows that the two varieties differed significantly from each other in this respect.

TABLE 4a.—*Comparative yield in piculs of sugar per ton of cane of plant crop*

VARIETY	REPLICATIONS						TOTAL	MEAN
	1	2	3	4	5	6		
College 39	1.54	1.49	1.38	1.48	1.11	1.22	8.22	1.37
S. No. 93	1.25	1.06	1.21	1.15	1.35	1.22	7.24	1.20
Total	2.79	2.55	2.59	2.63	2.46	2.44	15.46	
Mean	1.39	1.27	1.29	1.31	1.23	1.22		

TABLE 4b.—*Yield in piculs of sugar per ton of cane of ratoon crop*

VARIETY	REPLICATIONS						TOTAL	MEAN
	1	2	3	4	5	6		
College 39	1.67	2.13	2.01	1.92	1.90	1.95	11.58	1.93
S. No. 93	1.78	1.76	1.78	1.57	1.36	1.82	10.07	1.68
Total	3.45	3.89	3.79	3.49	3.26	3.77	21.65	

SMD (V) at 1% = 3.47

Actual and computed yields of canes and sugar. The actual yield of canes in kilograms to a plot of the two varieties in the plant crop is shown in table 5a. College 39 gave a mean yield of 944.5 kilograms while Seedling No. 93 gave a mean yield of 1,144.6 kilograms of canes to a plot. Seedling No. 93 gave a significantly higher yield of canes than College 39.

College 39 gave a computed mean yield of 86.39 tons of canes and 118.65 piculs of sugar and Seedling No. 93, a computed mean yield of 104.21 tons of canes and 125.79 piculs of sugar to a hectare.

Table 5b shows the yield of canes in kilograms to a plot of the two varieties in the ratoon crop. College 39 produced a mean of 936.2 kilograms and Seedling No. 93, 897.6 kilograms of canes to a plot. There was no significant difference between the yields of College 39 and Seedling No. 93.

College 39 gave a computed yield of 78.01 tons of canes and 150.56 piculs of sugar and Seedling No. 93, 74.80 tons of canes and 125.60 piculs of sugar to a hectare.

TABLE 5a.—*Actual yield in kilograms of millable stalks to a plot of plant crop*

VARIETY	REPLICATIONS						TOTAL	MEAN
	1	2	3	4	5	6		
College 39	1,122.7	802.2	879.6	974.6	938.1	949.5	5,666.7	944.5
S. No. 93	1,093.0	1,022.6	1,278.4	1,120.2	1,115.1	1,238.5	6,867.8	1,144.6
Total	2,215.7	1,824.8	2,158.0	2,094.8	2,053.2	2,188.0	12,534.5	
Mean	1,107.9	912.4	1,079.0	1,047.4	1,026.6	1,094.0		

SMD (V) at 5% = 47.85

TABLE 5b.—*Actual yield in kilograms of millable stalks to a plot of ratoon crop*

VARIETY	REPLICATIONS						TOTAL	MEAN
	1	2	3	4	5	6		
College 39	1,381.4	730.0	915.2	764.2	861.6	964.5	5,616.9	936.2
S. No. 93	959.8	763.6	928.0	926.1	931.7	876.4	5,385.6	897.6
Total	2,341.2	1,493.6	1,843.2	1,690.3	1,793.3	1,840.9	11,002.5	

* * *

Concern for man himself and his fate must always form the chief enterest of all technical endeavors.

—*A. Einstein*

* * *

Physics and Chemistry are the study of parts which determine the behavior of their wholes; biology is the study of wholes which determine the behavior of their parts.

—*Durant*

CAROTENE AND NITROGEN CONTENT OF IPIL-IPIL LEAVES

Ipil-ipil (*Leucaena glauca* Linn.) has been found to be one of the most important aids in tropical agriculture and dairy farming. It is a useful ingredient of livestock feeds.

Because of the importance of ipil-ipil as source of protein, nitrogen and carotene, the leaves were analyzed for these constituents from different postions, *i.e.,* from base to tip of branch and from base to top of the plants.

The ipil-ipil plants grown from seeds planted on October 25, 1955 on experimental plots were harvested on July 16, 1956, each having seven branches. This was identified as *first harvest.* All the first to the seventh branches in this harvest were grouped together. The leaves of all these branches were divided into three portions—the portion nearest the trunk, the middle, and the tip, labelled correspondingly as I-A, I-B, and I-C. The leaves of the main trunk were divided into 3 portions: the lower, middle, and top, and labelled correspondingly as X-A, X-B and X-C. The 24 samples were analyzed for total nitrogen and carotene.

A month later, ten plants were taken from the same experimental plots, each having again seven branches. This constituted the *second harvest.* These plants were sampled in the same manner as those in the first harvest and were likewise analyzed for total nitrogen and carotene.

Except for total nitrogen, which was analyzed by the modified Kjeldahl method, the other constituents (carotene, moisture, etc.) were determined in accordance with those adapted by the Association of Agricultural Chemists.

Table 1 shows the results obtained from the two harvests. Leaves from the same harvest showed that younger leaves contained more total nitrogen than the older ones. 1-A (near the trunk, hence, older) contained 2.90 per cent, while 1-C (tip) contained 3.65 per cent. This was not, however, true for carotene.

The results from the two harvests, however, apparently show that the older the plants, the higher the total nitrogen content in all portions of the plant. This seems to be true also with carotene although there was a greater variability.

TABLE 1.—*Analysis of ipil-ipil leaves (dry basis)*

BRANCH NO.	A		B		C		Average	
	Per cent Nitrogen	Mcg/100 g Carotene	Per cent Nitrogen	Mcg/100 g Carotene	Per cent Nitrogen	Mcg/100 g Carotene	Per cent Nitrogen	Mcg/100 g Carotene
				FIRST HARVEST				
1	2.90	19,881	3.02	19,593	3.65	29,057	3.19	22,844
2	3.59	15,478	3.68	23,519	3.78	25,767	3.68	21,588
3	3.37	23,794	4.34	24,361	5.18	24,452	4.30	24,202
4	4.12	24,828	5.23	32,176	5.65	33,859	5.00	30,288
5	4.33	33,505	4.99	34,006	5.04	34,997	4.79	34,169
6	4.85	31,912	5.66	24,453	5.81	24,094	5.44	26,820
7	4.62	26,165	5.32	23,735	5.80	23,735	5.25	24,545
X	3.12	17,180	4.16	17,734	5.02	17,670	4.10	17,528
				SECOND HARVEST				
1	3.08	21,187	3.79	27,521	3.85	28,340	3.57	25,683
2	4.20	29,722	4.48	23,187	4.75	25,013	4.48	25,974
3	4.12	23,975	4.47	26,529	4.95	27,850	4.51	26,118
4	4.44	24,970	5.35	24,259	5.86	27,715	5.22	25,648
5	4.54	26,554	4.73	26,262	5.69	29,265	4.99	27,360
6	4.96	29,703	5.70	31,796	6.01	32,862	5.56	31,454
7	5.16	33,847	5.58	31,948	6.01	39,180	5.58	34,992
X	3.57	21,215	4.28	26,868	5.44	24,092	4.43	24,058

[a] A is portion nearest the trunk; B, middle portion; C, tip of the leafy branch.

—Mamerta M. Ylagan and Salud S. Sanchez

EFFECT OF "VIGOFAC" ON THE RATE OF GROWTH OF GROWING AND FATTENING PIGS

"Vigofac", an unidentified feed supplement produced by fermentation, is claimed to be effective in promoting growth of pigs in the United States. To find out whether or not this claim will hold true in the Philippines, an experiment on eight Berkjala and twelve Berkshire-Berkjala two-month old pigs was conducted. The pigs divided equally into lot I (control) and lot II (experimental) were fed basal rations for three 8-week feeding periods. The basal ration given to lot 11 was supplemented with 0.136 per cent "vigofac".

At the end of the entire 24-week feeding period the basal-fed pigs made an average gain in weight of 28.31 kilograms and the "vigofac"-fed pigs, 27.93 kilograms. Results also showed that the basal-fed pigs consumed 5.56 kilograms feed and "vigofac"-fed pigs, 5.62 kilograms for every kilogram gain in weight. These results apparently did not show the growth-promoting effectiveness of "vigofac" on growing and fattening pigs as it does in the United States. Moreover, the addition of "vigofac" increased both, the feed required to make a kilogram gain in weight and the cost of feed.

—*Quirino M. Sugon*

COPPER CONTENT OF SOME SOIL SAMPLES FROM COCONUT GROVES OF LAGUNA AND QUEZON PROVINCES

Since Velasco (1957)[1] suggested that the cadang-cadang disease of coconut could be closely associated with low copper content of the soil, it was thought of interest to survey the copper content of soils in Laguna and Quezon, where coconuts are reputed to be free from the disease. Soil samples up to a depth of 6 inches were taken from various coconut groves along the road surrounding Mt. Banahaw at approximately ten-kilometer intervals. The copper contents of the samples were determined in the laboratory using the *Aspergillus niger* bio-assay technique (Kitchen, 1948).[2] The data on condition of the groves, color and texture of the soil, and the copper content are presented in table 1.

If it is arbitrarily assumed that a copper content of less than 2.0 microgram per gram of soil is deficient, then it may be expected that only the area around Kilometer Post 90 in Pila, Laguna, would encounter some trouble with copper. The trees in this area are worth further study because they show many of the characteristics of the cadang-cadang affected trees in the Bicol Region. They are yellowish, unthrifty with water-soaked specks, and hardly fruiting at all.

The unhealthy conditions in some of the coconut groves like those in Cavinte, Laguna, must have been brought about by unfavorable factors other than copper deficiency.

—*J. R. Velasco, E. M. Palmquist and E. B. Mamawal*

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[1] Velasco, J. R., *Philippine Agriculturist*, **41**, 157-170 (1957).

[2] Kitchen, H. B. (ed.), "Diagnostic techniques for soils and crops," The American Potash Institute, Washington 6, D.C., 1948.

TABLE 1.—*Characteristics of various soil samples from coconut groves in Laguna and Quezon*

SAMPLE NUMBER	LOCATION Km. Post	Town	SOIL COLOR AND TEXTURE (moist)	CONDITION OF GROVE	COPPER CONTENT IN μg. PER GRAM (1)	(2)	(3)	Average
1	77	Calauan, Laguna	Clay loam; very dark brown	Heavy bearing; a few yellow blotches in old leaves; 20 meters	2.50	2.50	2.50	2.50
2	83	Victoria, Laguna	Clay loam; very dark brown	Light bearing; small crown; yellowish; 40 meters	2.25	2.39	2.50	2.38
3	90	Pila, Laguna	Sandy loam; very dark brown	No fruits; general yellowing; water-soaked specks especially at base of pinnae; cadang-cadang(?)	1.66	2.08	2.08	1.94
4	103	Pagsanjan, Laguna	Clay loam; dark reddish brown	Medium bearing; general yellowing	2.39	2.39	2.50	2.33
5	108	Cavinti, Laguna	Clay loam; dark yellowish brown	Heterogenous; many trees unthrifty	2.50	2.50	2.50	2.50
6	114	Cavinti, Laguna	Clay loam; very dark brown	Light bearing; yellow; 8 meters tall	2.29	2.43	2.50	2.41
7	121	Luisiana, Laguna	Clay loam; very dark brown	Heavy bearing; dark green; 20 meters tall	2.50	2.50	2.50	2.50
8	129	Lucban, Quezon	Clay loam; very dark brown	Heavy bearing; 30-40 meters tall	2.50	2.50	2.50	2.50
9	158	Lucban, Quezon	Loam; very dark brown	Heavy bearing; 30 meters tall	2.50	2.50	2.50	2.50
10	150	Tayabas, Quezon	Clay loam; very dark brown	Medium bearing; some trees, yellow; 25 meters tall	2.50	2.50	2.50	2.50

TABLE 1 (continued)

SAMPLE NUMBER	LOCATION Km. Post	LOCATION Town	SOIL COLOR AND TEXTURE (moist)	CONDITION OF GROVE	COPPER CONTENT IN μg. PER GRAM (1)	(2)	(3)	Average
11	144	Lucena, Quezon	Clay loam; very dark brown	Heavy bearing; 30 meters tall	2.50	2.50	2.50	2.50
12	134	Sariaya, Quezon	Clay loam; black	Heavy bearing; some trees, yellow; 35 meters tall	2.20	2.29	2.47	2.32
13	126	Sariaya, Quezon	Clay loam; black	Medium bearing; dark green; 20 meters tall	2.30	2.29	2.50	2.36
14	117	Candelaria, Quezon	Sandy; black	Heavy bearing; green; 30-40 meters tall	—	2.30	1.87	2.08
15	108	Tiaong, Quezon	Silty clay loam; black	Medium bearing; yellowish; 25 meters tall	2.50	2.39	2.50	2.47
16	99	San Pablo, Laguna	Fine sand; black	Heavy bearing; green; 30-40 meters tall	—	2.30	2.35	2.32
17	89	San Pablo, Laguna	Sandy loam; black	Heavy bearing; green; 30-40 meters tall	2.50	—	2.42	2.46
18	78	Calauan, Laguna	Clay loam; dark brown	Heavy bearing; green; 30 meters tall	2.50	—	2.42	2.46
		College, Laguna	Clay loam; very dark brown	Heavy bearing	2.50	2.50	2.50	2.50
		Pili, Camarines Sur	Loamy sand; black	Trees affected by candang-cadang	—	1.43	1.87	1.65

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